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(54) Title: REGISTRATION FOR MOBILE NODES IN WIRELESS INTERNET PROTOCOLS
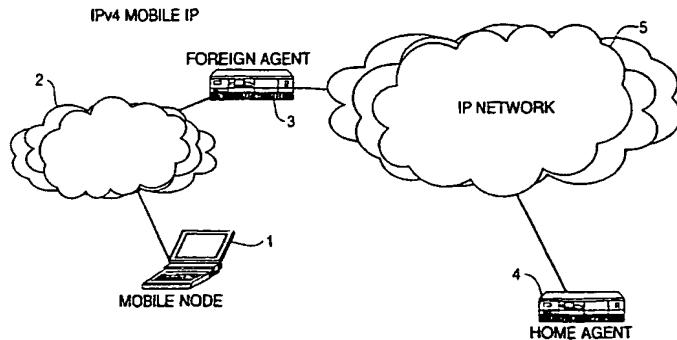
(57) Abstract: A re-registration authorization extension is attached to a registration request sent from a mobile node roaming on a foreign network or to any other data packet sent from the mobile node. The mobile node requests registration with its home network in order to maintain communication with the Internet and maintain identification of the mobile node by its individual home address, regardless of the mobile node's current location relative to the Internet. Such registration has a limited lifetime, and the re-registration authorization extension attached to the registration request or other data packet authorizes an intermediate communication entity in the foreign network to re-register the mobile node, on behalf of the mobile node, with the mobile node's home network, if the communication traffic of the mobile node indicates that the mobile node is still roaming on the foreign network. Furthermore, such re-registration authorization data can be transmitted from the mobile node in a data packet without being included in an extension therefore. That is, the re-registration authorization data does not have to be included in an extension. Regardless, whether it is transmitted via an extension or included in a data packet transmitted from the mobile node, by the re-registration authorization, the rate of error is reduced by significantly reducing the amount of transmissions sent from the mobile node, and power consumption of the typically battery-powered mobile unit is reduced, as well.

For two-letter codes and other abbreviations. refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

REGISTRATION FOR MOBILE NODES
IN WIRELESS INTERNET PROTOCOLS

BACKGROUND OF THE INVENTION

The present invention relates to methods for registering
and re-registering mobile nodes with their home network while
roaming in a foreign network.

A mobile node is a terminal which is able to change its
point of connection to a packet data network, which includes,
but is not limited to, the Internet, from one network or sub-
network to another. For the sake of the present discussion,
all references to the Internet which follow in this
specification will be presumed to include all other packet
data networks.

Mobile Internet Protocol (Mobile IP) allows mobile nodes
to roam from network to network or move from place to place
within a network while maintaining communication with the
Internet and maintaining identification of the mobile node by
its individual home address, regardless of the mobile node's
current connection to the Internet. Mobile IP is described in
the work-in-progress by Perkins et al. in "IP Mobility
Support", IETF Mobile IP Working Group, RFC 2002, 1996, and is
herein incorporated by reference.

Using the known IPv4 protocol shown in Fig. 1, when a
mobile node 1 has determined that it has roamed into a foreign
network, that is, any network that is not the home network of
the mobile node, the mobile node must register itself on the
foreign network in order to establish and maintain a

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connection to the Internet via the home network of the mobile

node. Such registration is limited in duration and

registration may be performed repeatedly. In other words,

registration enables the mobile node which is roaming on a

5   foreign network to receive all data packets addressed to the

mobile node's individual Internet home address on its

respective home network. Accordingly, the mobile node can

always be reached at its home address, regardless of the

foreign network that it is located in. Furthermore, the

10   mobile node must re-register itself in the foreign network if

the duration of the mobile node's stay in the foreign network

exceeds the duration of the validity of the original

registration.

In Fig. 1, first a foreign agent 3, which is a router on

15   the foreign network, periodically sends out messages

indicating its availability for service on behalf of mobile

nodes roaming thereon. These "agent advertisements" enable

the mobile node to first determine if it is on its home

network or on a foreign network. The "agent advertisements"

20   further provide the mobile node with a "care of" address,

which is a temporary address reflecting a roaming mobile

node's current point of connection to the Internet, at which

the mobile node can be reached if it is on a foreign network.

If the mobile node determines that it is roaming in a

25   foreign network, based on information provided in the agent

advertisement, the mobile node 1 sends a registration request,

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which includes the "care of" address, to the available foreign

agent 3 which then forwards the registration request to the

home agent 4 of the home network 5 of the mobile node. The

home agent 4 sends a registration reply to the foreign agent 3

5   acknowledging the registration. By having the mobile node 1

register its current location in a foreign network with its

home agent, the home agent 4 is able to create or modify a

mobility binding (i.e., the association of the home address of

the mobile node to the care-of address thereof) and therefore

10   the mobile node 1 can receive data packets addressed to its

individual home address which are forwarded by the home agent

thereof. In IPv4, the registration request from the mobile

node 1 and the registration reply from the home agent 4 are

sent via User Datagram Protocol (UDP).

15   As a result of the mobile node's registration, the home

agent 4, which is a router on the mobile node's home network

5, encapsulates data packets addressed to the mobile node's

home network address in an IP tunnel directed to the care-of

address provided by the mobile node. The foreign agent 3

20   receives the encapsulated IP packets, and forwards them to the

mobile node 1. Furthermore, it should be noted that the

mobile node 1 uses its individual home address as the source

address of all IP data packets that it sends, even when on the

foreign network.

25   Mobile IP version IPv6, shown in Fig. 2, does not utilize

a foreign agent to acquire "care-of addresses" for the mobile

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nodes 1, unlike the case for IPv4. Rather, IPv6 has built-in

mobility support and utilizes "co-located care-of addresses,"

whereby the mobile nodes acquire the co-located care-of

addresses themselves. Such methods for acquiring the co-

5   located care-of addresses for IPv6 are described in the work-

in-progress by Johnson et al. entitled "Mobility Support in

IPv6" IETF Mobile IP Working Group, 1998, which also is

incorporated herein by reference.

According to the IPv6 Mobile IP, a roaming mobile node 1

10   registers one of its co-located care-of addresses with a

router on its home network 6, requesting the router to

function as the home agent 4 for the mobile node. This is

accomplished when mobile node 1 performs "binding"

registration which is the association of the mobile node's

15   home address with its co-located care-of address by sending a

data packet including a "binding update" destination option to

the home agent 4, to thereby make known the mobile node's

primary care-of address to the home network. Acknowledgment

of the binding update data packet is then forwarded from the

20   home agent 4 to the mobile node 1. The binding update data

packet and acknowledgment thereof between the mobile node 1

and the home agent 4 is transmitted using Internet Control

Message Protocol (ICMP). The home agent then uses proxy

neighbor discovery to intercept IPv6 data packets addressed to

25   the mobile node's home address on the home link and tunnels

any intercepted packet to the mobile node's primary care-of

4

address. The aforementioned proxy neighbor discovery is
described in the Johnson reference.

A known format of the Mobile IP Registration Request sent
from the mobile node to the foreign agent or to the home
5   agent, as described above, is depicted in Fig. 3. As
described in RFC 2002, the Mobile IP fields Registration
Request include the following fields, which are common for
both IPv4 and IPv6 Mobile IP, except where noted:

<u>Type</u>:

10 identification as a Registration Request;

<u>S</u>:

Simultaneous bindings. The mobile node is requesting that the
home agent retain its prior mobility bindings;

<u>B</u>:

15 Broadcast datagrams. The mobile node is requesting that the
home agent tunnel any broadcast data packets addressed to the
mobile node's home network address to the mobile node at its
care-of address;

<u>D</u>:

20 Decapsulation by the mobile node. The mobile node is
indicating that it will decapsulate data packets that are sent
to the care-of address itself, that is the mobile node is
using a co-located care-of address (for IPv6);

<u>M</u>:

25 Minimal encapsulation. The mobile node is requesting that its
home agent use minimal encapsulation for data packets tunneled
to the mobile node;

<u>G</u>:

Encapsulation. The mobile node is requesting that its home

agent use a specified standard of encapsulation for data

packets tunneled to the mobile node;

5   <u>V</u>:

The mobile node is requesting that either the home agent or

foreign agent use Van Jacobson header compression over the

corresponding link with the mobile node;

<u>rsv</u>:

10   Reserved bits;

<u>Lifetime</u>:

The amount of time (in seconds) remaining for valid

registration of the mobile node;

<u>Home Address</u>:

15   The IP address of the mobile node;

<u>Home Agent</u>:

The IP address of the mobile node's home agent;

<u>Care-of Address</u>:

The IP address for tunneling of data packets;

20   <u>Identification</u>:

A 64-bit number used for matching Registration Requests with

Registration Replies, composed by the mobile node; and

<u>Extension(s)</u>:

The fixed portion of the Registration Request can be followed

25   by one or more extensions. The extension mechanism allows

optional information to be carried by Mobile IP control

messages or by ICMP Router Discover messages. Extensions are

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encoded in a Type-Length-Value format, as shown in Fig. 4.

The format of the Extensions includes the following fields:

<u>Type</u>:

Indicates the particular type of Extension;

5   <u>Length</u>:

Indicates the length (in bytes) of the data field within the

extension. The length does not include the Type and Length

bytes; and

<u>Data</u>:

10   The particular data associated with the extension.

Extensions allow variable amounts of information to be

carried within each data packet. RFC 2002 defines two types

of extensions. The first type of extension for Mobile IP can

only appear in Mobile IP control messages, that is, to and

15   from a UDP port. These extensions are Mobile-Home

Authentication Extensions, Mobile-Foreign Authentication

Extensions and Foreign-Home Authentication Extensions.

Mobile-Home Authentication Extensions are utilized to

authenticate registration requests. For example, when a

20   mobile node includes a Mobile-Home Authentication Extension in

the registration requests sent therefrom, the home agent is

thus able to verify the integrity of the request. The second

type of extensions can appear only in ICMP Router Discovery

messages and are One-byte Padding Extensions, Mobility Agent

25   Advertisement Extensions and Prefix-Length Extensions.

As mentioned briefly above, the lifetime or duration of

such registration of a mobile node roaming on a foreign

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network is limited, and therefore the mobile node must re-

register on the foreign node if it wishes to maintain its

connection to the Internet and receive forwarded

communications from its home agent at its care-of address.

5   Such re-registration repeats the same procedures

discussed above. Therefore, consideration of re-registration

of a mobile node on a foreign network must take into account

the fact that the mobile node's connection to the Internet is

usually a low bandwidth wireless link 2 (in both Figs. 1 and

10   2) which is susceptible to a rate of error which is higher

than that for a wired network. Such low bandwidth links

include, but are not limited to, GSM/PSTN, CDMA or TDMA

communication protocols. Furthermore, mobile nodes are very

often battery-powered, and therefore repeated registrations in

15   the foreign network would exhaust the power supply thereof.

Therefore, it would be prudent to reduce the number of

transmissions from the mobile node on such a low bandwidth

link in order to reduce the rate of transmission error and

also to reduce energy consumption by the mobile node.

20   However, the presently known registration systems for Mobile

IP described above, including IPv4 and IPv6, have not

contemplated any steps or means for compensating for the

deficiencies associated with repeated registrations of the

mobile nodes in the foreign networks in which they

25   respectively roam in order to maintain a connection with the

Internet via the home network of the mobile node.

SUMMARY OF THE INVENTION

Therefore, the present invention is an improvement of
Mobile IP which reduces traffic on the low bandwidth link
between a mobile node and the foreign agent for IPv4 and the
5   mobile node and the home agent for IPv6, and reduces power
consumption by the mobile node by significantly reducing the
number of transmissions by the mobile node for both IPv4 and
IPv6 Mobile IP, thus overcoming the deficiencies of the prior
art described above.

10   In particular, the present invention provides an
extension attached to the Registration Request sent from the
mobile node to the foreign agent, for IPv4, or the home agent,
for IPv6, which provides authorization for the foreign agent
or some other intermediate communication entity in the foreign
15   network on which the mobile node is roaming to re-register the
mobile node with the home agent of the mobile node's home
network. Such an extension providing authorization for the
foreign agent or some other intermediate communication entity
in the foreign network to re-register the mobile node with the
20   home agent of the mobile node's home network can also be
attached any other data packet transmitted from the mobile
node, including an authentication data packet.

That is, by utilizing the extension mechanism defined for
Mobile IP, which allows optional information to be carried by
25   Mobile IP control messages for IPv4 or by ICMP messages for
IPv6, the present invention provides authorization for a
router, dial-up server or other communication entity in a

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foreign network on which a mobile node is roaming to register

and re-register the mobile with the mobile node's home

network, so that all IP data packets forwarded to the

individual home address of the mobile node are forwarded

5   thereto, regardless of the location of its connection to the

Internet.

When a mobile node has left its home network and received

an agent advertisement from the foreign network on which it is

presently roaming to thereby confirm its roaming status, the

10   mobile node sends out a registration request to the foreign

agent in the foreign network in order to establish a

connection to the Internet, in the case of IPv4 Mobile IP, or

sends a binding update data packet to an intermediate

communication entity in the foreign network. Utilizing the

15   home address information of the mobile node that is included

in the registration request, the foreign agent forwards the

mobile node's registration request to the home network of the

mobile node in the case of IPv4 Mobile IP, or the intermediate

communication entity of the foreign network forwards the

20   binding update data packet in the case of IPv6 Mobile IP.

The home agent is, as an example, a router on the mobile

node's home network. In the case of IPv4 Mobile IP, the home

agent then forwards a registration reply to the foreign agent

which, in turn, forwards the registration reply to the mobile

25   node. In the case of IPv6 Mobile IP, the home agent sends a

binding update acknowledgment through an intermediate

communication entity in the foreign node. Assuming a positive

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reply from the home agent, for any of the protocols described above, the home agent is then able to tunnel Internet data packets addressed to the mobile node's individual home address to the mobile node on the foreign network, utilizing a care-of

5   address which has been assigned to the mobile node.

In submitting the registration request to the foreign agent in the case of IPv4 Mobile IP, or in submitting the binding update data packet to the intermediate communication entity in the foreign network in the case of IPv6 Mobile IP,

10   the mobile node attaches a re-registration authorization extension to the body of the registration request or binding update data packet. Thus, either the foreign agent or the intermediate communication entity in the foreign network will re-register the mobile node with the home agent of the mobile

15   node's home network. The authorization for re-registration has an entitlement which exceeds the lifetime of the authorized registration of the mobile node in the foreign network. Thus, if the foreign agent or intermediate entity determines that the mobile node is still roaming on the

20   foreign network based upon the detected communication traffic for the mobile node, the foreign agent or intermediate entity will re-register the mobile node's presence in the foreign network with the home agent thereof.

Alternatively, the registration request may be sent

25   without an extension including the re-registration authorization. Instead, after the mobile node has been registered in the foreign network, the mobile node may

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transmit data packets to its home network, wherein the data

packets include the extension having the re-registration

authorization, in accordance with the extension described

above.

5   Furthermore, the re-registration authorization does not

have to be transmitted via an extension as described above.

That is, a data packet transmitted from the mobile node after

the mobile node has been registered in the foreign network may

include re-registration authorization data without having an

10   extension therefore.

Further still, the re-registration authorization may be

included in the Mobile-Home Authentication extension which may

be attached to the registration request so that the home agent

is able to verify the integrity of the registration request.

15   In this instance, the re-registration authorization extension

is placed before the Mobile-Home Authentication extension so

that the home agent is able to verify the integrity of the

registration request and the re-registration authorization.

Accordingly, the need for repeated registration

20   transmissions between the mobile node and the foreign agent or

intermediate communication entity is significantly reduced,

thereby reducing the likelihood of error in the low bandwidth

transmission link there between, and consequently the number

of transmissions sent forth from the mobile node are

25   significantly reduced, as well, thereby reducing energy

consumption by the mobile node, which is likely to be battery

powered.

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BRIEF DESCRIPTION OF THE DRAWINGS

The scope of the present invention will be apparent from the following detailed description, when taken in conjunction with the accompanying drawings, and such detailed description,

5 while indicating preferred embodiments of the invention, are given as illustrations only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description, in which:

10 Fig. 1 illustrates a prior art network architecture in which a mobile node is roaming on a foreign network, wherein the mobile node's home network is a known IPv4 network;

Fig. 2 illustrates a prior art network architecture in which a mobile node is roaming on a foreign network, wherein

15 the mobile node's home network is an IPv6 network;

Fig. 3 shows a prior art User Data Protocol (UDP) registration request;

Fig. 4 shows a prior art extension to the registration request of Fig. 3;

20 Fig. 5 shows a registration request according to the present invention, wherein the extension is a re-registration authorization extension; and

Fig. 6 shows the re-registration authorization extension of the present invention.

25 DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The present invention, as shown in Fig. 5, provides a

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registration request sent from a mobile node roaming on a foreign network, as described above.   The registration request of Fig. 5 includes all of the fields described above in connection with the registration request of Fig. 3, except for

5   the extension which will be described below.   Therefore, description of the registration request will be presently omitted.   Furthermore, the present invention enables the mobile node to roam from network to network or move from place to place within a network while maintaining communication with

10   a packet data network, which includes, but is not limited to, the Internet.   For the sake of the present discussion, all references to the Internet which follow in this specification will be presumed to include all other packet data networks.

       The registration request of Fig. 5 includes a re-

15   registration authorization extension which authorizes the foreign agent, in the case of IPv4 Mobile IP, or the intermediate communication entity, in the case of IPv6 Mobile IP, to re-register the mobile node with the home agent of the mobile node's home network when the lifetime of the previous

20   registration has expired.

       Thus, in the case of IPv4 Mobile IP, according to the present invention, the re-registration authorization extension attached to the registration request authorizes the foreign agent to re-register the mobile node on the foreign network

25   after the lifetime of the previous registration thereof has expired.   As described above in connection with the prior art, the valid lifetime registration for the mobile node on a

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foreign network is included in the registration request.

Thus, after the mobile node has sent a registration request to the foreign agent, the foreign agent has forwarded the registration request to the home agent, and the home agent has

5   sent an affirmative acknowledgment to the foreign agent which forwards the acknowledgment to the mobile node, the mobile node is then able to receive forwarded data packets addressed to its individual home address from the home agent through the connection established on the foreign network. When the

10   lifetime of the registration of the mobile node is set to expire, the foreign agent checks the communication traffic to and from the mobile node. If the results of the check of the mobile node's communication traffic indicate that the mobile node is still roaming on the foreign network, the foreign

15   agent re-registers the mobile node's presence on the foreign network with the home agent of the mobile node's home network on behalf of the mobile node.

Thus, the mobile node is not required to initiate the re-registration itself, thereby significantly reducing the number

20   of transmissions between the mobile node and the foreign agent, which further reduces the rate of error particularly if the connection there between is a low bandwidth communication link.

It should be noted that either of the home network and

25   foreign network can be a wireless network, and the entities for the foreign agent include, but are not limited to, a router. Most typically, the foreign network is the wireless

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network, and the mobile node is connected thereto utilizing a
low bandwidth communication link which could include, but is
not limited to, GSM/PSTN, CDMA or TDMA communication
protocols. Such networks to which the present invention is
5   applicable are the same as those depicted in the prior art
figures described above, and therefore description thereof is
presently omitted.

Furthermore, even the re-registration authorization
included in the extension attached to the registration request
10   sent from the mobile node to the foreign agent has a limited
lifetime. Therefore, when the valid lifetime of the re-
registration authorization is set to expire, if the mobile
node wishes to remain registered on the foreign network, the
mobile node must send a renewed registration request to the
15   foreign agent. The re-establishment of the registration
follows the original registration procedures described above.
The renewed registration request may further include a renewed
re-registration authorization extension for the same purposes
and functions described above.

20   For IPv6 Mobile IP, registration of the mobile node on
the foreign network is established as described above in
connection with the prior art. As in the case of IPv4 Mobile
IP described above, either of the home network and foreign
network can be a wireless network. For IPv6 Mobile IP, since
25   foreign agent are not required to assign a care-of address to
the mobile node as in the case of IPv4 Mobile IP, the
intermediate communication entity in the foreign network

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utilized for re-registering the mobile node on the foreign

network may include, but is not limited to, a de-fault router

of the foreign network or a dial-up server in the foreign

network. Furthermore, it is likely that the foreign network

5   is a wireless network, and the mobile node is connected

thereto utilizing a low bandwidth communication link which

could include, but is not limited to, GSM/PSTN, CDMA or TDMA

communication protocols.

         Based on the method and system described above for

10   authorizing a communication entity in a foreign network to re-

register a mobile node that is roaming on the foreign network

with the mobile node's home network, the present invention is

able to significantly reduce the rate of error in

communication from the mobile node by reducing the number of

15   transmissions therefrom. That is, reduced transmissions on

the typically low bandwidth communication link established by

the mobile node reduce the rate of error. Furthermore, by

authorizing the intermediate entity in the foreign network to

re-register the mobile node on the foreign network by

20   utilizing a re-registration authorization extension attached

to the registration request, thereby reducing the amount of

transmissions sent from the mobile node, the active life of

the typically battery-powered mobile node is significantly

extended.

25   For both IPv4 and IPv6, another embodiment of the present

invention attaches the re-registration authorization extension

not to the registration request but rather to a data packet

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transmitted from the mobile node after registration of the

mobile node in the foreign network. Such re-registration

extension is attached to a data packet in accordance with the

extension described above. Furthermore, such data packets

5   transmitted from the mobile node after registration of the

mobile node in the foreign network may include re-registration

authorization data independent of an extension therefore.

That is, re-registration authorization data, as described

above, does not need to be transmitted via an extension to a

10   registration request or a data packet. Rather, the re-

registration authorization data may be included in a data

packet itself.

Further still, the extensions the re-registration

authorization data may be included in the Mobile-Home

15   Authentication extension which may be attached to the

registration request so that the home agent is able to verify

the integrity of the registration request. In this instance,

the re-registration authorization is placed before the Mobile-

Home Authentication extension so that the home agent is able

20   to verify the integrity of the registration request and the

re-registration authorization.

While the present invention has been described in detail

and pictorially in the accompanying drawings, it is not

limited to such details since many changes and modifications

25   may be made thereto without departing from the spirit and

scope of the present invention. It is intended that all such

modifications fall within the scope of the following claims.

We claim:

1.   A method for a second network to register and re-register a mobile node for communication with a first network, said method comprising the steps of:

    sending from said mobile node a registration request to said second network, said registration request including an extension thereof;

    registering by said second network said mobile node for communication with said first network; and

    re-registering by said second network said mobile node for communication with said first network in accordance with said extension of said registration request.

2.   A method according to Claim 1, wherein said extension is a re-registration authorization extension.

3.   A method according to Claim 2, wherein said re-registration authorization extension is encoded in Type-Length-Value format.

4.   A method according to Claim 2, wherein said re-registration authorization extension is valid for a limited duration.

5.   A method according to Claim 4, further comprising the step of:

3   sending a renewed registration request which includes a

4   new re-registration authorization extension from said mobile

5   node to said second network when the limited duration of the

6   validity of said re-registration authorization extension has

7   expired.

1   6.   A method according to Claim 1, wherein said first

2   network is a home network for said mobile node.

1   7.   A method according to Claim 1, wherein said second

2   network is a foreign network in which said mobile node is

3   roaming.

1   8.   A method according to Claim 1, wherein said

2   registration request is received in a router of said second

3   network.

1   9.   A method according to Claim 8, wherein said router

2   of said second network is a default router.

1   10.   A method according to Claim 1, wherein said

2   registration request is received in a dial-up server in said

3   second network.

1   11.   A method according to Claim 1, wherein said second

2   network registers said mobile node with a server in said first

3   network.

1   12.   A method according to Claim 1, wherein said second

2   network is a wireless network.

1   13.   A method according to Claim 1, wherein said second

2   network registers said mobile node for communication with said

3   first network after said first network has transmitted an

4   affirmative registration reply to said second network.

1   14.   A method according to Claim 1, wherein said second

2   network re-registers said mobile node for communication with

3   said first network if said second network determines that said

4   mobile node is active in said second network.

1   15.   A method according to Claim 2, wherein said

2   registration request is configured for IP Network Control

3   Protocol (IPCP).

1   16.   A method according to Claim 2, wherein said

2   registration request is configured for Link Control Protocol

3   (LCP).

1   17.   A system for maintaining a home network connection

2   for a mobile node, comprising:

3   a first network;

4   a second network; and

5   a mobile node which has a home address in said first

6   network,

7   wherein when said mobile node roams in said second

8   network said mobile node sends a registration request

9   including an extension of said registration request to said

10 second network,

11   wherein said second network in response to said

12 registration request registers said mobile node for

13 communication with said first network, and re-registers said

14 mobile node for communication with said first network in

15 accordance with said extension of said registration request.

1   18. A system according to Claim 17, wherein said

2   extension is a re-registration authorization extension.

1   19. A system according to Claim 18, wherein said re-

2   registration authorization extension is valid for a limited

3   duration.

1   20. A system according to Claim 17, wherein said

2   registration request is received in a router of said second

3   network.

1   21. A system according to Claim 20, wherein said router

2   of said second network is a default router.

1   22. A system according to Claim 17, wherein said

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2   registration request is received in a dial-up server in said

3   second network.

1   23.   A system according to Claim 17, wherein said second

2   network registers said mobile node with a server in said first

3   network.

1   24.   A system according to Claim 17, wherein said second

2   network is a wireless network.

1   25.   A system according to Claim 17, wherein said second

2   network registers said mobile node for communication with said

3   first network after said first network has transmitted an

4   affirmative registration reply to said second network.

1   26.   A system according to Claim 17, wherein said second

2   network re-registers said mobile node for communication with

3   said first network if said second network determines that said

4   mobile node is active in said second network.

1   27.   A system according to Claim 18, wherein said

2   registration request is configured for IP Network Control

3   Protocol (IPCP).

1   28.   A system according to Claim 18, wherein said

2   registration request is configured for Link Control Protocol

3   (LCP).

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1   29. A method for a second network to register and re-

2   register a mobile node for communication with a first network,

3   said method comprising the steps of:

4   registering by said second network said mobile node

5   for communication with said first network;

6   sending data from said mobile node to said first

7   network; and

8   re-registering by said second network said mobile

9   node for communication with said first network in accordance

10   with said data.

1   30. A method according to Claim 29, wherein said data

2   includes re-registration authorization data.

1   31. A method according to Claim 30, wherein said re-

2   registration authorization data is encoded in Type-Length-

3   Value format.

1   32. A method according to Claim 30, wherein said re-

2   registration authorization data is valid for a limited

3   duration.

1   33. A method according to Claim 32, further comprising

2   the step of:

3   sending further data which includes new re-registration

4   authorization data from said mobile node when the limited

duration of the validity of said re-registration authorization

data has expired.

34.   A method according to Claim 29, wherein said first

network is a home network for said mobile node, and said

mobile node has a home address on said first network.

35.   A method according to Claim 29, wherein said second

network is a foreign network in which said mobile node is

roaming.

36.   A method according to Claim 29, wherein said data is

received in a router of said second network.

37.   A method according to Claim 36, wherein said router

of said second network is a default router.

38.   A method according to Claim 29, wherein said data is

received in a dial-up server in said second network.

39.   A method according to Claim 29, wherein said second

network registers said mobile node with a server in said first

network.

40.   A method according to Claim 29, wherein said second

network is a wireless network.

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1   41.   A method according to Claim 29, wherein said second

2 network registers said mobile node for communication with said

3 first network after said first network has transmitted an

4 affirmative registration reply to said second network.

1   42.   A method according to Claim 29, wherein said second

2 network re-registers said mobile node for communication with

3 said first network if said second network determines that said

4 mobile node is active in said second network.

1   43.   A method according to Claim 30, wherein said

2 registration request is configured for IP Network Control

3 Protocol (IPCP).

1   44.   A method according to Claim 30, wherein said

2 registration request is configured for Link Control Protocol

3 (LCP).

1   45.   A system for maintaining a home network connection

2 for a mobile node, comprising:

3   a first network;

4   a second network; and

5   a mobile node which has a home address in said first

6 network,

7   wherein when said second network registers said mobile

8 node for communication with said first network in response to

9 a request from said mobile node, said mobile node transmits

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10   data to said first network, and

11   wherein said second network re-registers said mobile node

12   for communication with said first network in accordance with

13   said data.

1   46. A system according to Claim 45, wherein said data

2   includes re-registration authorization data.

1   47. A system according to Claim 46, wherein said re-

2   registration authorization data is valid for a limited

3   duration.

1   48. A system according to Claim 45, wherein said data is

2   received in a router of said second network.

1   49. A system according to Claim 48, wherein said router

2   of said second network is a default router.

1   50. A system according to Claim 45, wherein said data is

2   received in a dial-up server in said second network.

1   51. A system according to Claim 45, wherein said second

2   network registers said mobile node with a server in said first

3   network.

1   52. A system according to Claim 45, wherein said second

2   network is a wireless network.

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53. A system according to Claim 45, wherein said second
network registers said mobile node for communication with said
first network after said first network has transmitted an
affirmative registration reply to said second network.

54. A system according to Claim 45, wherein said second
network re-registers said mobile node for communication with
said first network if said second network determines that said
mobile node is active in said second network.

55. A system according to Claim 46, wherein said
registration request is configured for IP Network Control
Protocol (IPCP).

56. A system according to Claim 46, wherein said
registration request is configured for Link Control Protocol
(LCP).

57. A method according to Claim 1, wherein said
extension is a Mobile-Home Authentication extension.

58. A method according to Claim 57, wherein said Mobile-
Home Authentication extension includes re-registration
authorization data.

59. A system according to Claim 17, wherein said

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2   extension is a Mobile-Home Authentication extension.

1   60. A system according to Claim 59, wherein said Mobile-

2   Home Authentication extension includes re-registration

3   authorization data.

FIG. 1
(PRIOR ART)
IPv4 MOBILE IP
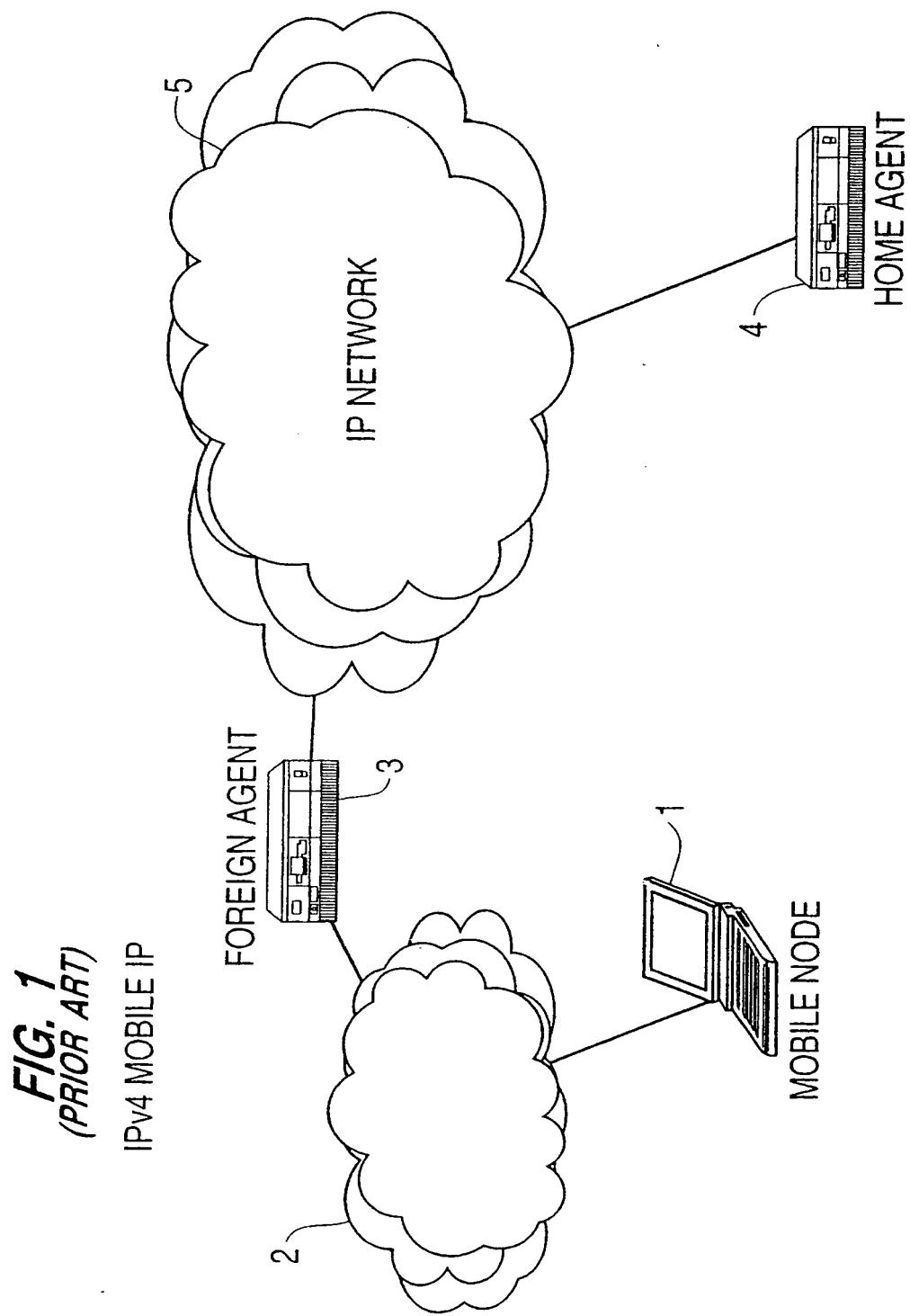
FIG. 2
(PRIOR ART)
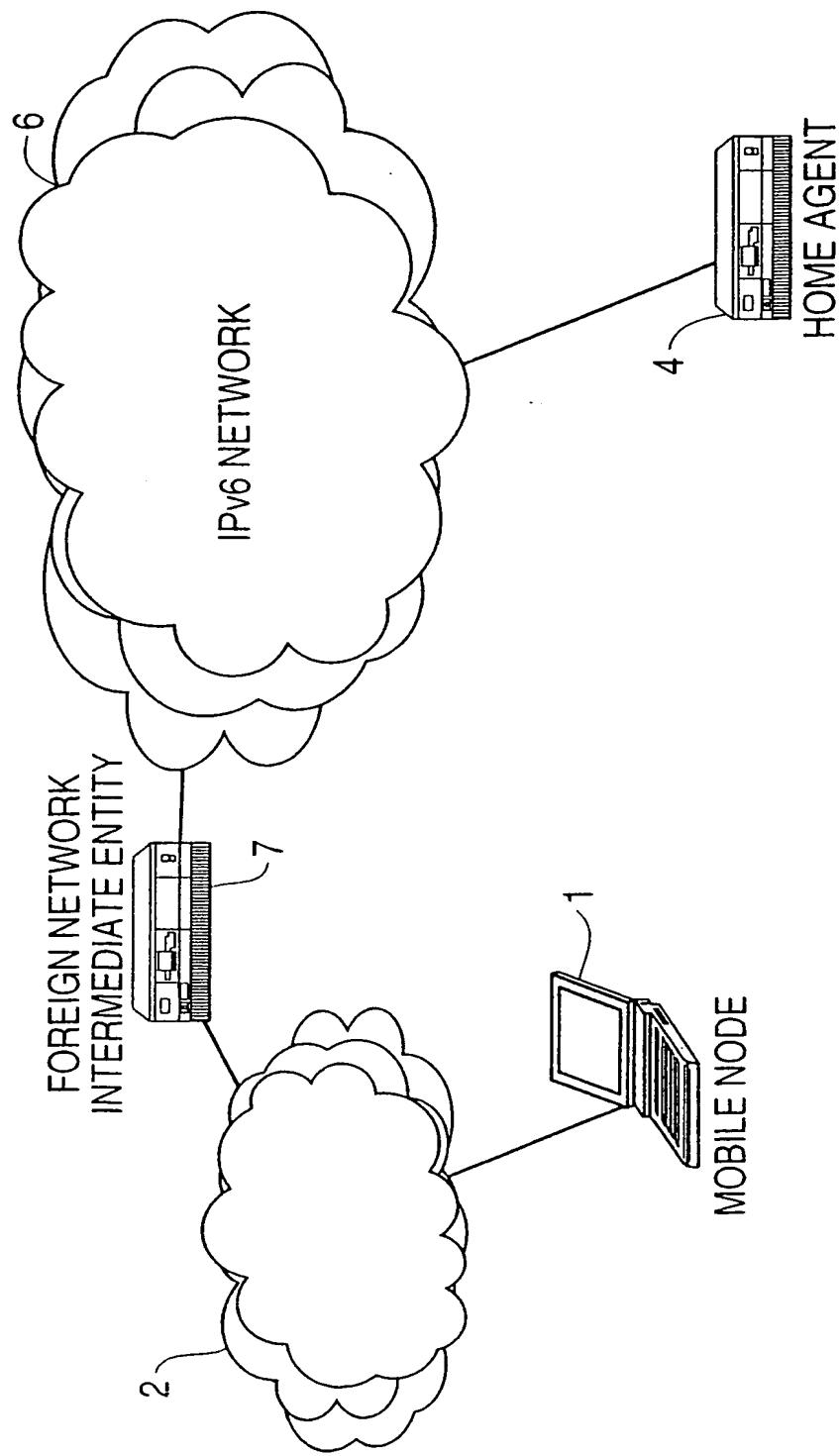
FIG. 3
(PRIOR ART)

Type	S	B	D	M	G	V	rsv	Lifetime
Home Address								
Home Agent								
Care-of Address								
Extensions								

FIG. 4
(PRIOR ART)

Type	Length	Data ...

FIG. 5

Type	S	B	D	M	G	V	rsv	Lifetime

Home Address

Home Agent

Care-of Address

Registration Authorization Extension

FIG. 6

Type	Length	Data ...

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   H04L29/06   H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7   H04L   H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	LI Y ET AL: "PROTOCOL ARCHITECTURE FOR UNIVERSAL PERSONAL COMPUTING" IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS,US,IEEE INC. NEW YORK, vol. 15, no. 8, 1 October 1997 (1997-10-01), pages 1467-1476, XP000721278 ISSN: 0733-8716 page 1470, right-hand column, line 43 -page 1471, right-hand column, line 58 -/--	1,17,29, 45

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 October 2000	16/10/2000

Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Authorized officer López-Pérez, M-C

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	PERKINS C E: "MOBILE IP" IEEE COMMUNICATIONS MAGAZINE,US,IEEE SERVICE CENTER. PISCATAWAY, N.J, vol. 35, no. 5, 1 May 1997 (1997-05-01), pages 84-86,91-99, XP000657114 ISSN: 0163-6804 page 91, left-hand column, line 41 -page 92, left-hand column, line 8	1,17,29, 45
A	US 5 862 482 A (BEESLEY GRAHAM EDGAR) 19 January 1999 (1999-01-19) the whole document	1,17,29, 45

1

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Information on patent family members

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			DE 19637441	A	20-03-1997
			FR 2738982	A	21-03-1997
			GB 2305335	A,B	02-04-1997